Harley Davidson Tech. 1

1) Intro Dates.
   a) 883: started in early 1986 to present
   b) 1100: started in late 1986 to late 1987
   c) 1200: started in early 1988 to present

(Case breather sportsters from 1986-1990, Iron sportsters from 1957-1985)

2) Compression Ratio
   a) 9:1 on ALL models

3) Rocker covers
   a) Big Twins (B/T) and Sportsters(XL) can be interchanged as a set
      i) Top end breather covers must be used on top end breather motors
      ii) Print-o-seal gasket and inner cork or rubber (chimney) are the same for B/T and XL
      iii) All rubber gaskets from late 1989 till current
      iv) XL rocker arms and shafts are the same as the B/T

4) Rocker arm play is 0.003" to 0.013" between rocker arm and rocker box (endplay!)

5) Bolts are hardened and CANNOT be replaced or mixed with unhardened bolts

6) Rocker shaft to Rocker box clearance for all XL's is 0.0007" to 0.0022" (ID to OD clearance)

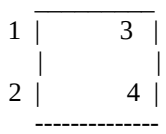
7) 9/16ths 18 tap is used to push out rocker arm bushings (from the opposite side) – then press in new bushings

8) Pushrod tubes
   a) 1986-1990
      i) multipiece tube
      ii) both top and bottom seal against an o-ring

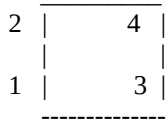
9) Cylinder Head
   a) Early 883 – egg shaped chamber and sand cast
   b) Late 883 – round/hemispherical shaped chamber, die cast
   c) 1986 to early 1987 1100 – egg shaped chamber, sand cast
   d) Late 1987 1100 and all 1200 – round/hemispherical shaped chamber, die cast
   e) Late 1100 heads were milled 0.040"
      i) That milling did not continue on the 1200

Torque pattern →→→ Front cylinder

1/8th turn at a time



Torque to 7ft/lb, then 14ft/lb Rear cylinder
Then turn ¼ turn (90degrees)



10) Early head bolts have large spacers, later ones have a flange built onto the stud (changed 90/91)
    a) Lightly oil bolt after cleaning – used as anti-seize

11) Rocker arm bolts – longer bolt is on the pushrod side

12) Valves
    a) 883 has the smallest
    b) 1100 from 1986 to early 1987 were the same as the B/T (1340) valves
    c) 1100 in late 1987, decreased diameter of valves
        i) Late 87 1100 and all 1200 valves are the same size
        ii) The change resulted in better mid-range
    d) XL's have longer valve stems than B/T
    e) There are no service values available

13) Cylinders
    a) Different castings between the 3 different motors
        i) 883, 1100 and 1200 stamped into bottom right corner of cylinder
        ii) cylinders are all the same length and use the same sleeve
        iii) sleeve is just bored out more for the larger displacement
            (1) stock bore
                (a) 883 – 3.00"
                (b) 1100 – 3.35"
                (c) 1200 – 3.50"
                (d) 883 can be bored out to 1200

14) pistons
    a) Karl Schmidt (German)
    b) 1986 to early 1989 – no offset on piston for 883 and 1100 – install either direction
    c) late 1989 to present – 883 and 1200 pistons have offset with the arrow on piston crown facing forward
    d) As of October, 1994 – 883 pistons are coated with Teflon for break-in

15) Piston pin
    a) 883 is shorter than 1100 or 1200 (diameter is the same)
    b) 1200 same 1340, but are NOT interchangeable
    c) 1200 have either '12' or a 'V' grove stamped on the edge

16) Tappets
    a) XL same as B/T
    b) No restrictor on Early 1986
    c) Ristrictor added Late 1986-1990
        i) Reduces oil to the top end
        ii) Helps keep lifter filled at highway speeds (hydraulic lifters as opposed to solid)
    d) Tappet working ranges

17) Tappet block – 4 speed
    a) To remove from case, turn tappet block and lift from case
    b) Tappet to block fit
        i) 0.0008" to 0.0023"
        ii) 0.003" service wear
        iii) there are no stock oversizes available
    c) new o-rings are made from silicone rubber and will swell when exposed to oil
    d) oil leaks
        i) tappet block to case – oil will be 'grungy'
        ii) small o-ring to case – oil will be dirt-free; possible that the counterbore is to deep in the case (should be 0.050" – 0.060")

iii) shim up with a small washer
iv) use Hylomar to seal

e) Torque to 15-18 ft/lbs

18) Gearcase cover
a) Bolt torque patterns given in Tech Tips 25
b) 2 dowel pins are for centering cover
c) computerized sizes for gear fitment
i) quadrex – room temp of 68 degrees
ii) measures center to center of bushings down to 0.00000 (hundred thousandths)
iii) prints sheet telling what cams to use
iv) production covers have no markings, but information is on file at HD
v) P&A covers are color coded for correct cam selection
(1) PN – 25488-86 – cover with cams and pinion gear ('T' cams)
(2) Cover only retrofits all alternator covers - 84 ½
d) Service of gearcase area
i) Replace cover? – order cover and cams as a set
ii) Replace bushings?
(1) Must line ream

19) Cams
a) 1986-1987 – 'T' cams
i) same cam in 883 and 1100
ii) dogbone installed with the chamfer facing cam (out)
b) 1988-1990 – 'C' cams
i) same cam used in 883 and 1200
ii) reduced emissions
iii) dogbone installed with chamfer facing cam (out)

20) flywheels
a) 3 piece flywheels
i) 1 piece flywheel halves
ii) no retrofit except left side wheel from pre-comonized to comonized – must rebalance
b) oil restrictor in the pinion shaft
c) no rear cylinder advance mark
d) balance factors (used to balance at speed – higher % = balance at higher RPM, lower % = lower RPM balance)
i) 1340 – 60%
ii) 1100 – 69% (blue)
iii) 883 – 62% (yellow)
iv) 1200 – 62% (white)
v) after 1989, all 883 flywheels are colored green and all 1200's are red
e) 1991 and later, there's a timing mark on right side flywheel

21) Connecting rods
    a) Dog legged (1982 and later – ALL Evos)
    b) Wrist pin clearance is 2 times that of a B/T, helps prevent seizure
    c) Bearings
        i) Early 1986 were loose rollers with flat thrust washers
        ii) Late 1986 through current use F.A.G. bearings (started on day 095)
    d) For the first 2 months, no thrust washers were used; added late May
        i) Stepped for clearance; wider cage
    e) Service just like the B/T bearings
        i) 1 bearing size, 3 sizes of crank-pin

22) Sprocket Shaft
    a) 5-speed shaft is 0.750" longer than 4-speed
        i) Rotor and stator moved to sprocket shaft from clutch shell
        ii) Rotor pressed and screwed to socket

23) Pinion shaft and race
    a) 1986 only – unitized (caged) bearing pressed into case
        i) Race pressed onto shaft 1.185"-1.195" from flywheel race
        ii) Grind to size: 1.2485"-1.249", 16rms finish
    b) 1987-current uses F.A.G. bearing
        i) 3 pieces
            (1) outer race pressed into case
            (2) inner race pressed onto shaft
            (3) separate bearings
        ii) 4 sizes of bearing
        iii) races press to different depths, see service manual
    c) 1988 to current – pinion shaft
        i) Pinion shaft is straight, no splines
        ii) Pinion gear is light press fit and keyed to shaft
            (1) Reduces gear runout = better cam fit
        iii) New pinion gear
        iv) Nut has NO locktab so use locktite and torque to specs

24) Breather system – 4-speed
    a) Same as alternator iron XL engine
        i) Plastic baffle
        ii) Umbrella valve
    b) Small hole under the valve to relieve oil buildup at breather
        i) Hole must be open or air-cleaner will get oil

25) Oil pump – 4-speed
    a) Operation is the same as –77 pump
    b) Feed gear height: 0.001'-0.011" above pump cover
    c) Feed gears were enlarged to supply lifters
        i) Return gears are still larger than feed
    d) Gear clearance – inner and outer gear
        i) Wear limit = 0.004"
        ii) Use shaft to center gears in body
    e) Seal lip (numbers side) toward feed side
    f) Oil pressure
        i) Measure at the top plug in the case or the sending unit on the filter housing
            (1) Factory specs: 1-7psi at idle and 5-30psi at 2500 rpm
            (2) If taken at the sending unit, readings will be double
    g) Oil flow
        i) Flows from oil tank to the pump cover

ii) Feed gear pressurizes oil through small hose to housing
    (1) Special hoses – 2 different fitting sizes, no sealant needed
iii) Oil filter adapter housing
    (1) Pressurized oil to adapter housing
    (2) Enters adapter through drilled holes and fills cavity
    (3) Builds 2-4psi, activates sending unit and oil light turns off
    (4) Cold oil pressure = high oil pressure
    (5) Pressure regulator bleeds off excess oil to gearcase; opens at 16-18psi
    (6) Regulator left out or stuck open = lifter collapse and oil pressure drop
    (7) Oil through filter to center of filter
    (8) Oil through check valve
        (a) Opens at 4-6psi
        (b) Check valve creates backpressure, activates sending unit faster
        (c) Arrow on valve indicates direction of flow
        (d) Should point towards adapter with o-ring to the outside – counter bore
        (e) If installed backwards, it will damage the o-ring and create unfiltered path for oil flow
        (f) Late 1987 has a new valve – rubber ball, spring and new fitting
            (i) Ball to change in material and size; m-950
                1. Some sticking shut
                2. Also redesign of adapter
        (g) 1992 production change; ball was changed again; has a tail; PN 33116-86A
iv) oil back to pump through large hose
v) through pump and into engine case and gearcase cover
vi) first to lower end
    (1) restrictor on pinion shaft reduces oil flow to rods
    (2) increases oil flow to top end
vii) path through gearcase cover and case sends oil to tappet blocks, lifters, pushrods and rocker arms
viii) all other areas are splash and drip

!! Iron heads – 80% oil to bottom end, 20% to top end !!
!! Evo engines – 20% oil to bottom end, 80% to top end !!

ix) oil returns though cylinder drain holes and pushrod tubes
    (1) oil collects in mini-sump
    (2) oil collects in gearcase cover and drains into mini-sump
x) 3 things control oil return
    (1) spinning of flywheel and case scraper
    (2) downward action of the piston creating pressure in the case
    (3) suction of oil pump return gears

Harley Davidson Tech. 1

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    a) 1986-1990
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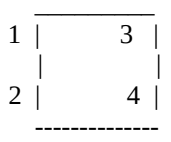

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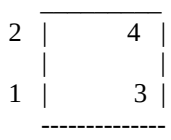
Rear cylinder



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            (2) Cover only retrofits all alternator covers - 84 ½

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    ii) Replace bushings?
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    a) 3 piece flywheels
        i) 1 piece flywheel halves
        ii) no retrofit except left side wheel from pre-comonized to comonized – must rebalance
    b) oil restrictor in the pinion shaft
    c) no rear cylinder advance mark
    d) balance factors (used to balance at speed – higher % = balance at higher RPM, lower % = lower RPM balance)
        i) 1340 – 60%
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        iv) 1200 – 62% (white)
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        i) Stepped for clearance; wider cage
    e) Service just like the B/T bearings
        i) 1 bearing size, 3 sizes of crank-pin

47) Sprocket Shaft
    a) 5-speed shaft is 0.750" longer than 4-speed
        i) Rotor and stator moved to sprocket shaft from clutch shell
        ii) Rotor pressed and screwed to socket

48) Pinion shaft and race
    a) 1986 only – unitized (caged) bearing pressed into case
        i) Race pressed onto shaft 1.185”-1.195” from flywheel race
        ii) Grind to size: 1.2485”-1.249”, 16rms finish
    b) 1987-current uses F.A.G. bearing
        i) 3 pieces
            (1) outer race pressed into case
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    c) 1988 to current – pinion shaft
        i) Pinion shaft is straight, no splines
        ii) Pinion gear is light press fit and keyed to shaft
            (1) Reduces gear runout = better cam fit
        iii) New pinion gear
        iv) Nut has NO locktab so use locktite and torque to specs

49) Breather system – 4-speed
    a) Same as alternator iron XL engine
        i) Plastic baffle
        ii) Umbrella valve
    b) Small hole under the valve to relieve oil buildup at breather
        i) Hole must be open or air-cleaner will get oil

50) Oil pump – 4-speed
    a) Operation is the same as –77 pump
    b) Feed gear height: 0.001’-0.011” above pump cover
    c) Feed gears were enlarged to supply lifters
        i) Return gears are still larger than feed
    d) Gear clearance – inner and outer gear
        i) Wear limit = 0.004”
        ii) Use shaft to center gears in body
    e) Seal lip (numbers side) toward feed side
    f) Oil pressure
        i) Measure at the top plug in the case or the sending unit on the filter housing
            (1) Factory specs: 1-7psi at idle and 5-30psi at 2500 rpm
            (2) If taken at the sending unit, readings will be double
    g) Oil flow
        i) Flows from oil tank to the pump cover
        ii) Feed gear pressurizes oil through small hose to housing
            (1) Special hoses – 2 different fitting sizes, no sealant needed
        iii) Oil filter adapter housing
            (1) Pressurized oil to adapter housing
            (2) Enters adapter through drilled holes and fills cavity
            (3) Builds 2-4psi, activates sending unit and oil light turns off
            (4) Cold oil pressure = high oil pressure
            (5) Pressure regulator bleeds off excess oil to gearcase; opens at 16-18psi
            (6) Regulator left out or stuck open = lifter collapse and oil pressure drop
            (7) Oil through filter to center of filter
            (8) Oil through check valve
                (a) Opens at 4-6psi
                (b) Check valve creates backpressure, activates sending unit faster
                (c) Arrow on valve indicates direction of flow
                (d) Should point towards adapter with o-ring to the outside – counter bore

(e) If installed backwards, it will damage the o-ring and create unfiltered path for oil flow
(f) Late 1987 has a new valve – rubber ball, spring and new fitting
(i) Ball to change in material and size; m-950
1. Some sticking shut
2. Also redesign of adapter
(g) 1992 production change; ball was changed again; has a tail; PN 33116-86A

iv) oil back to pump through large hose
v) through pump and into engine case and gearcase cover
vi) first to lower end
(1) restrictor on pinion shaft reduces oil flow to rods
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!! Evo engines – 20% oil to bottom end, 80% to top end !!

ix) oil returns though cylinder drain holes and pushrod tubes
(1) oil collects in mini-sump
(2) oil collects in gearcase cover and drains into mini-sump
x) 3 things control oil return
(1) spinning of flywheel and case scraper
(2) downward action of the piston creating pressure in the case
(3) suction of oil pump return gears

PRIMARY DRIVE AND COVER

1. Clutch cable

A. sits below oil level
B. Hylomar on threads
C. copper washer under nut
D. don’t damage o-ring (part of cable.no seperate part number
E. some cables leak at crimped area; replace
F. 88 clutch cable
1). o-ring at end
2). adjustable in middle of cable
3). 88 primary cover changed for o-ring
4). cable will retro fit to 86

2. Clutch adjustment

A. disconnect battery
B. slacken clutch cable all the way
C. remove clutch screw lock and spring
D. turn counterclockwise until firm
E. turn clockwise 1/4 to 1/2 turn
F. replace screw lock and spring

G. adjust cable for1/16” cable freeplay

3. Primary chain adjustment

   A. disconnect negative battery terminal
   B. take out slack in primary chain
   C. rotate wheel to find tight spot
   D. adjust to 3/8 to 1/2” slack

4. Oil level and type

   A. H-D sport transmission fluid
      1). designed for higher loads
      2). retrofits all wet clutches
   B. 4 speed
      1). 24 oz. measured
      2). fluid should just dribble out of level plug with motorcycle upright
   C. 5 speed
      1). 32 oz. measured or just up to diaphragm spring on clutch

5. Cover removal

   A. disconnect battery
   B. release chain adjuster
   C. remove clutch screw nuts
   D. remove fasteners

6. Clutch release

   A. powdered metal
   B. M-923 late model parts
      1). angle of ramp and coupler changed, helps prevent breakage caused by misalignment
   C. retro fits as set to 84 1/2

7. Motor sprocket and chain same since ‘57

   A. torque to 150-160 ft-lbs. use Loctite 242
   B. use lock link tool to hold sprocket

8. Motor sprocket nut

   A. it was first a grade 2 hex nut
   B. than a grade 5 hex nut
   C. now a grade 8 nut with a flange

D. torque to 150-165ft-lbs. Use Loctite 262

9. Source of oil leaks at primary

   A. gasket surface
   B. shift shaft seal to cover
   C. foot peg shaft
   D. starter motor
   E. clutch cable
   F. screw adjuster

CLUTCH XL 4 SPEED

1. General

   A. snap ring assembly
   B. can be removed piece by piece or as a complete assembly
   C. use a clutch spring compressor for disassembly

2. Clutch spring

   A. diaphragm- same strength as old double coil
   B. special washers; round edge to spring

3. Clutch

   A. fiber (friction)-drive
      1). .010" max warpage
      2). .130" minimum thickness
      3). when installing new, soak in oil for at least 5 minutes
   B. steel-driven
      1). .010" max warpage
      2). .060" minimum thickness
      3). stamped steel, <u>smooth rounded edge faces out</u>

4. Spring plate

   A. check for loose rivets
   B. measure for variance; max. of .020"

5. Rotor

   A. part of clutch shell assembly, magnets are fragile

6. Clutch hub bearing

    A. beefed up L86, reduces looseness

ACCESS DOOR, XL 4 SPEED

1. Stator mount
2. Torx screws

    A. 30-40 in-lbs.
    B. loctite encapsulated on threads

3. Before removal, measure transmission shaft end play
4. To remove access cover, shock dowel pins or heat around dowel pins

TRANSMISSION XL 4-SPEED

General

A. 4 Speed
B. Direct drive
C. 1 to 1 ratio in 4th gear
D. Sliding gear
E. Sprocket: 21T, Right hand threads; 65-90 ft lbs

Check end play of main shaft and counter shaft before removing access door

Gear spacing can be accomplished by changing shift forks and/or spacer washers

    A. Forks come in standard, ±.005, ±.010, or ±.020 sizes. This changes spacing of individual sliding gears.
B. Different thickness washers used to adjust spacing of gears on countershaft.
C. Use go/no go, method of spacing (in hand out)

Cam follower detent problems; M-949

A. L84 - E87 Steel zinc
B. M87 - L87 aluminum
C. L87 - 90 aluminum w/counter bore

Mainshaft

A. 1st gear largest dia. gear
   1) M-934 recall 061
      a) 87:28T gear, some break, switched back to -52A gear, 27T
      2) Radius on all 1st gears to case for lubrication.
         a). press off/on with the bearing races
   B. mainshaft 2nd and 3rd gears
      1). same ratio since '57
      2). 3rd gear end play reduced by thicker washer- running change 1986
         a). will retro fit to 1957
      3). M-906 late gears, smaller diameter
         a). must be used on all 1100's
         b). early or late model ok on 883
         c). prevents root contact caused by 1100 shaft flexing
         d). OK to mix early or late style on all xl models except 1100 or 1200
   C. mainshaft 4th gear (clutch gear)
      1). needle bearing
      2). running 1986 thrust washer it has a loose fit
         a). oil slots to the outside, don't use
      3). 1987 ratio change
         a). E-17T
         b). L-18T, ID by groove in teeth
         c). taller 1st through 3rd
   D. Mainshaft
      1). .003" max bend
      2). check with freewheeling gears and V-blocks

6. Countershaft

   A. 1st gear, smallest diameter gear
      1). needle bearings
   B. Countershaft 2nd and 3rd gears
      1). same ratio since 1957
      2). M-906, gear diameter reduced, running 1986
         a). must be used on 1100
         b). early or late style ok on 883
   C. Countershaft 4th gear
      1). step towards door-thrust washer
      2). 1987 ratio change
         a). E-27T
         b). L-26T, grove on face of gear
      3). flip KM transmission plate over
         a). measure from end of splines to slider
         b). use chart in manual to determine washer size
   D. End play
      1). mainshaft = .006"-.020", no preload

2). countershaft = .004”-.015”, use spoke to pull on shaft
3). proceedure
a). install without washers
b). measure end play and write it down
c). use charts in manual to determine washer size
d). reassemble and double check door bolt torque, 14 ft-lbs.

GENERAL

1. 66-69, generator bottom end. 70-84, AC generator (cone motor) (magnet spins around windings)
2. Installation of engine (right side)

A). rock motor corner to corner to check fit.
B). torque down rear motor mount
C). check front mount and frame for clearance (shim any clearance), than torque front mount
D). inspect clearance between top mount and frame. shim for “0” clearance, than torque.

3. Engine and tranny proceedure

A). install engine
B). loosely bolt primary to engine
C). with tranny and plate loose, bolt primary to tranny
D). shim primary than torque engine and primary. than torque tranny and primary
E). torque tranny and plate

4. Rocker box installation torque pattern

5. Head bolt installation torque pattern

6. Rocker box

A. Cut out provides clearance between cover and frame when engine is hot
1). engine expands approxamately .040” (measured from cylinder deck to top of rocker box).
B. Rocker shaft location, 1 degree negative angle places rocker arm lower on valve

side. spins valve to prevent lead build up, quieter, supposed to keep arm thrusted to one side

C. Gasket- torque to 12-15 ft-lbs. 300 percent increase when engine reaches operating temperature. assemble dry or with lithium grease (H-D says dry).

D. Max warpage- .006"

E. 78 1/2 late style rocker box. Boss under front for "ham can" mounting and shortened boss on back left side using shorter stud.

F. Rocker arms (2 types)

1). front exhaust/ rear intake and front intake/ rear exhaust

2). case hardened, max wear or pitting, more than .005", replace (pad or socket area)

3). 66'-70' rocker arms were copper plated (-66 arms)

71'-up, iron arm with more even wear (-66A arms, will retro fit)

82'-up, had a ground out 1 degree to offset for negative angle in the cover(pad area)

4). rocker arm end play

a). specs. .004"-.025" . Good is .004"-.010"

b). alter end play

(1). best method, cut a shoulder on the shaft

(2). good method, chamfer rocker arm spacer (5/8-3/4 countersink, 90 degree angle

(3).bad method, shim the rocker arm (<u>do not do this</u>)

5). rocker shaft

a). -66A part number if o-ring seat is square. -66B part number if o-ring seat is beveled

b). specs. shaft to arm, .003" max clearance
shaft, .0015" max wear
shaft to box, .002" max clearance

(1). excessive clearance in these areas will cause flooding of the valve pocket area.

c). see hand out page 3-1 for additional information

G. Pushrod

1). all 4 identical

2). inspect for:

a). damaged ends

b). damaged locknuts

c). max bend .010"

H. Pushrod Tubes

1). 79' and earlier, cork gasket, flat edge tube

2). L79'-84 1/2', o-ring gasket, lip edge tube. (for more compression, use cork in place of middle o-ring).

7. CYLINDER HEADS

A. Specs.
1). head gasket surface, max warpage of .006”
2). head gasket types, Teflon = blue, Graphite = black, Metal fiber = gray (James gasket with metal fire ring and silicon bead). Install all gaskets dry
3). torque- 55-75 ft-lbs. staged, 30,45,55. (always start next to oil hole).
DO NOT GO OVER 65 FT-LBS. TOTAL, ALUMINUM.
4). fire ring height causes leaking or blown head gasket when excessive .010” clearance between head and cylinder
5). head bolt should be assembled with lube or “never seize”
6). additional information on page 3-2 of hand out

B. Cylinder prep for re-assembly
1). clean in soapy water
2). clean and lube with a paper towel and motor oil (light weight)
3). clean drain hole with a brush

C. 1980 heads
1). cast iron guides, longer with shoulder
2). head has machined surface for new style lower valve spring collar. collar now rests on head surface instead of valve guide shoulder
3). L81
a). cst iron guides, longer with shoulder
b). ream or hone for proper clearance, intake = .0015”, exhaust = .0025”
c). valve guide seals- umbrella type seals
NOTE- do not use loctite on a valve guide seal

D. Valves
1). hard valves- Eaton, hard chrome, US made.
Nittan, black nitride coating, Japan made.
2). stem diameter- 80’ valve diameter same as earlier models. 81’ valve is approximately .003” larger stem OD
3). 80 and 81 valves are recommended for use with all cast iron guides
4). medium hard valves, -57A and -66 valves are compatible with cast iron guides but not recommended due to short service life
5). soft valves, -57,-60 valves, never use soft valves with cast iron guides. (causes valve sticking).

E. Springs and hardware
1). spring ID- silver = 82’ and earlier, red/orange = L82-84 (prevents coil bind with “S” cam)
2). top retainer- mid 81 and earlier, thicker. L81 and up, .050” thinner for seal clearance
3). bottom collar- 79 and earlier, 9/16 ID. sits on guide shoulder
L81 and up, 3/4 ID. fits over seal, sits on head surface

F. Cylinders. cast iron all years. 1200cc = 3 7/16 bore. 1340cc = 3 1/2" bore.
1). 66' -78',1200cc, 10 fins with a thin base. (available untill 80' as an option).
2). 78 1/2 and up, 1340cc, 9 fins with a thick base. (1200cc option)
a). base is cut out for triangle washers, round side faces down.
3).when boring or honing, use torque plates and gaskets.
4). cylinder inspection:
a). base surface, .003" max warpage.
b). wear limits, max clearance, .006" cylinder to piston (.0015"-.003" good)
max taper, .002"
max out of round, .001"
c). finish #240 plateau (when sizing cylinder, use torque plates and gaskets)

G. Pistons
1). 60'-83', Bohnalite, USA made, H-D machined, cast in steel strut (controls expansion), tin coated for break in, symetric, no wrist pin offset, wrist pin clips 72'-77', spirolox and 77' and up use Tru arc (pistons will be marked with -78 part number or "77" cast into piston). can use a spirolox in a Tru arc piston, but not the reverse.
2). compression ratio:
a). 1200cc, high compression 8:1, FLH, (round dimple in crown)
b). 1200cc, low compression 7.4:1, FL, (no dimple)
c). 1340cc, high compression 8:1, FLH, (rough crown)
d). 1340cc, low compression 7.4:1, FL, (smooth crown)
3). wrist pin (see service bulletin- hand out page 3-15)
a).-74 pistons have lowered wrist pin locations for use with .030" shorter connecting rods
b). -53 and -55 pistons have higher wrist pin location for use with longer rods. (-36 and -41A)
4). piston clearance: .001"-.002" with a max of .006"
5). Mahle pistons-L83'-84'
a). German made
b). very hard (12% silicone content)
c). approximately 100 grams lighter than Bohnalite
d). wire type pin clip (use special Kent-Moore tool to install) gap at 12:00
e). wrist pin offset closer to rear of piston
(1). arrow faces forward
(2). lug (under skirt to left)
(3). pin closer to rear
6). Mahle piston shape
a). diamond turned process (barrel faced)
b). can retro fit to all 1340cc shovel head engines
c). things in common with the EVO; rings, pins,clips. nly difference is shovel pistons are domed, Evo are flat top
7). rings
a). 3 piece oil control, 1340cc, Dec. 78 and later, 1200cc, Jan. 79 and later

b). 3 piece oil control set features:
(1). top ring: barrel face
(2). 2nd ring: reverse twist taper face, scrapes on the way down, twists and hydroplanes on the way up
(3). bottom ring: 3 piece, rails top and bottom, expander in the middle. less cylinder wall tension than 1 piece ring, faster break in)
(i). L78' and earlier engines use 1 piece cast iron oil control ring and 2 chrome plated compression rings.
(4). 3 piece set will retro to earlier pistons

H. Tappet guides
1). 4 variations
a).66'-76 1/2, 1 small drain hole, countersunk screw holes
b). 76 1/2'-E81', small drain hole, straight screw holes
c). L81'-E82", no drain holes, had spigot for evacuator
d). L82' and up, 2 transfer holes, no spigot
2). inspection
a). check for cracks (base of roller guides)
b). check for wear (max .002" between tappet and guide)
3). mounting screws
a). 66'-77', 1/4 X 24
b). 74'-84', 1/4 X 20
4). updating
a).drill both drain holes through to the bottom with a 3/32" bit (or use 1/8")

I. Tappets (same all gears)(not including hydraulic units)
1). install with flat sides facing each other.
a). failure to install properly will prevent the exhaust from pumping up
2). inspection: .001" max tappet wear, and .0015" max roller bearing clearance
a). inspect tappet screen every time you change oil (open end down, spring over screen)

J. Hydraulic lifter
1). lifter test
a). dissassemble lifter unit, bleed and clean with contact cleaner
b). with unit dry, manually compress and hold for 6 seconds, when released, plunger should pop up
2). lifter problem causes
a). oil pressure, need a minimum of 12 PSI at 2000 RPM
b). oil path restriction, tappet screen blocked
c). tappet installed backwards
d). gasket misaligned at tappet guide
3). install tappet guide with installation tool in back (use every time to align tappets with cam)
4). similar noises often mistaken for lifter problems
a). excessive rocker arm end play

b). loose cam gear fit
c). exhaust leak
d). sticking valve
e). bent pushrod
f). worn tappet roller bearing

K. Cam, Breather, and Pinion Gear
1).cam endplay must be measured before cover is removed
2). breather gear endplay: using a new gasket , feeler gauge, and a straight edge. measure between straightedge and breather gear with the gasket in place. than subtract .006" for gasket crush. ideal endplay is .005"-.010"
3). cam fitment (see hand out page 2-15)
a). ideal, straight, no lash
b). loose fitment, = noise, clatter
c). tight fitment = whine
d). gear tooth changes (cam, pinion, breather)
(1). E77' and earlier, straight tooth profile
(2). L77' and later, curved tooth profile (machined ring on side of gear)
(i). 7 gear sizes identified by color codes
(3). never mix old and new style cam, breather, or pinion parts
4). Cam types
a)."H" cam, E83' and earlier. "S" cam, L83' and 84'
b). "S" cam, all parts and accessories, less duration than "H" cam, more mid range, quiter valve train (softer)
5). Gear inspection
a). lobes, discoloration and pits
b). bearing surfaces (change from INA to Torrington)
c). teeth
d). dog ear washer (installed eats down, slant towards rear)

G. 58'-72' One shot oiling system
72' and up, flat side bushing that lines up oil holes in the bushing with oil passage (constant oiling)

L. Solid lifter usage
1). can ruin hydraulic type cam, it has no expansion ramp
2). solid ype lifter cams need expansion (clearance) ramps to reduce shock on cam lobes, tappet rollers, and valve stems
3). solid lifters provide more cam lift than hydraulic lifters

M. Breather gear
1). 66'-E77', steel, straight tooth (small nipple end)
2). L77'-E81', steel, curved tooth (large nipple end)
3). L81' and up, Zytel plastic, curved tooth (uses 6 slot window)

N. Pinion and oil pump gear

1). pinion, 58'-E77', full tooth gear with straight profile
L77'-84', half tooth gear with curved profile. color coded availability
2). inspection, space rcollar should have end play
a). check oil pump drive gear installation, install so iinner chamfer faces flywheels
3). oil pump drive gear, 66'-72', 5 tooth, 73'-84', 6 tooth
4). oil pump driven gear, 66'-72', 25 tooth (5:1 ratio), 73'-84', 24 tooth (4:1 ratio, better), can retro fit as a set

O. Gear case cover
1). 66'-69', peanut style
2). 70'-72', cone style, one shot oil flow
3). 73'-84', cone style, full flow oil flow

P. Torque pattern for cam cover installation

Q. Cam timing

8. LOWER END

A. commonized and pre-communized parts (hand out page 2-16)
commonized parts L81' and later: service bulletin M829A
1). reason for change, more economical to manufacture and better fit at taper

	commonized	pre-commonized
pinion shaft	90 degree to keyway	135 degrees
right side flywheel crankpin	rear cyl. advance = lazy 8	no lazy 8

B. Changes to crankpin after commonized
1). L81'-L82', .140" center oil hole
2). L82'-84, .090" center oil hole
3). 84' and up, large offset oil hole

C. Connecting rods

1). 41'-73', long rods, no longer available, if old style pistons are retained for use with new style short rods

a). piston to flywheel clearance must be checked at BDC (should be 1/8" min)

b). compression ratio will be reduced from 8:1, to 7.6:1

2). 74'-82', short rods with slot, .030" shorter, center to center

3). 82'-E83', short rods with hole

4). L83'-84', short rods offset with hole (dog leg rods), 10 times the fatigue resistance (reduces bend and twist), wider web on female rod. requires new flywheels with relief

9. Oil pump

A. oil type

1). 40 degrees and lower	10/40 multigrade
2). 40-80 degrees	20/50 multigrade
3). 80 degrees and up	60 weight, extra heavy
4). 80-95 degrees	SAE 60
5). 95 degrees and up	SAE 70

B. oil pressure

1). measure at operating temperature, 180-220 degrees

2). spec.: idle, 3-5 PSI, 2000 RPM, 12-35 PSI

C. Feed system

1). gravity feed to "F" fitting on pump

2). check valve: a 2-3 lb spring and ball seals pump and prevents drain down when engine is not running (a leaking check valve causes tank drain down and blows oil out of breather on start up)

a). to repair, lap seat with bead blasted Evo pushrod end (it's the same size as the check ball)

3). after engine is running, check valve opens and oil flows to tappet screen, lifters, and top end

4). lower end passasge opens at 5-10 PSI (regulating piston moves upward to open passage), oil flows through crank case and gear case cover to pinion bushing

a). oil flows through pinion shaft, right side flywheel and crank pin

b). the oil lubricates the rod bearings

c). splash from rods lubes the pistons, pin bushings, and lower end bearings

5). relief passage opens at 12-18 PSI (L73'-81, oil directed to return side. L81' and up, directed to feed side relief)

6). hydrolocked oil (oil trapped above relief piston)L73'-80', down tower to return (ID, large cap), 81'-E82',to gear case (ID, small cap), 80' and earlier, had short piston and a rod to limit travel. L82' has long piston to block relief hole when not running to prevent drain down. rod deleted, long piston is its own travel limiter. also, make a groove so oil can get to hydrolock passsage when retro fitting

D. Breather system
1). pressures: positive, piston moving downward
negative, piston moving upwards
2). function, oil movement
a). pistons move downward,breather valve window is open and flywheel area blows oil into the gearcase
(1). gearcase area, normally positive
(2). cylinder area, normally positive (transfers through tappet guide holes)
b). when pistons move upwards, breather window closes and a negative pressure is created
(1). flywheel area, normally negative
c). there is a push/pull effect which helps drain oil from the top end
d). oil seperator (hole at bottom of breather trap, feeds to hole in breather valve bore at the 5 o'clock position, connects with breather trap area. holes align on negative pressure to draw oil from bottom of the trap)
e). hole in breather valve at 9 o'clock position is for primary oil return and should create a minimum of 25" water vacuum in the primary at 1500 RPM with vent line pinched (dry clutch model)
3). crankcase vent fitting, located above oil pump, connects to oil tank to prevent excessive pressure or vacuum
4). crankcase breather fitting, lowest fitting on back of case, connected to air cleaner to reroute vapors through the engine
5). evacuator system, used on E81"-E82' models, hose connected pushrod tube area to cylinders. system did not work- causing oil consumption, carbon deposits, and pushrod tube leaks
6). typical breather and return system problems cause oil carryover
a). return restriction
b). over filled oil tank
c). leaking check valve
d). damaged breather valve or case
e). seperator hole plugged
f). breather trap gasket leaking

E. Return system
1). oil drains to bottom of gearcase
2). thick gears (return) pick up oil
3). oil returns to tank through fitting next to "F" fitting at top of pump
4). oil may also flow through filter and cooler before returning to tank

F. Updates
1). L82' engine oil changes- reduce top end fitting to .090" (do this to all shovels)
2). drill the 2 holes through in the tappet guide
3). oil pump return (hand out page 3-9)
4). lip side of seal towards feed gears

10. Dry clutch
    A. 36'-84 1/2, dry multiplate with chain drive primary (oil feed/ oil retrieved by engine vacuum)
        1). primary is oil fed, oil is retrieved by engine vacuum (25" water vacuum at 1500 RPM, vent pinched)
    B. friction plates, .020" max warpage, can be scuffed up
    C steel plates, .010" max warpage, scars 1/32" or more, replace. grove wear .020" max
    D installation, friction plate first and last; crankcase seal installs lip in to keep engine oil out of dry primary

11. Clutch adjustment data

A. flat plate shifter	wet or dry clutch	13/16" measurement
B. ratchet top shifter	wet or dry clutch	1/2" measurement
C. 5 speed	wet clutch	3/4 turn out

12. AP wet clutch
    A. 84 1/2'-89', with 4 and 5 speed transmission
    B. lubricant- level bottom of clutch with motorcycle upright and level. Derby cover removed, fluid to bottom edge of diaphragm spring
    C. type- H-D primary chain case lubricant, 1 1/2 quart, change every 5,000 miles
    D. primary housing- extra fasteners added for rubber mountin 85' and 86' for rigid mount engines
        1). printo seal gasket
        2). primary vent through mainshaft and transmission vent, vent plugged = oil leak
        3). crankshaft seal installs lip lip side out to keep primary chain case lubricant from going into the engine
    E. clutch adjustment
        1). service, set up, check at 500 miles than every 5,000 miles
        2). proceedure:
            a). disconnect battery
            b). apply max slack to clutch cable
            c). loosen clutch screw and locknut
            d). inspect and adjust spring tension
                (1). spring attitude = flat $\pm$ .010"
                (2). spring tension adjustment:
                    (i). back out adjuster plate bolts 1/2 to 1 turn at a time
                    (ii). note position of bolts (A,B, or C)
                    (iii). change position as necessary
                    (iv). replace bolts 1/2 to 1 turn, loctite 222 on bolts, and torque to 6.5-8 ft-lbs.
            e). adjust clutch screw (5speed)
                (1). turn in until it touches
                (2). back out 3/4 turn and tighten locknut

f). adjust clutch screw (4speed)
(1). turn to position clutch arm 13/16" from transmission top
(2). tighten locknut
g). adjust cable to provide 1/8" to 3/16' cable freeplay between cable end and lever bracket

F. diaphragm spring- installs convex out
G. adjuster plate- provides three positions for spring attitude adjustment
H. pressure plate- release plate is held in with a tapered snap ring (installs with taper out)
I. updates:
1). mid92' parts and accesories change, adjuster plate no longer provides 3 positions for spring adjustment. suggest to use shims if necessary to space outward

13. Clutch plates
A. 6 driven plates
1). friction materials
a). STD: 84 1/2 to 8/4/86, no asbestos, heavy use could ruin
b). screaming eagle type: 8/5/86 to 5/12/88, paper construction, much better friction
c). sintered bronze type: 5/13/88 to 89' production, almost indestructable, some slippage with heavy use
2). service, minimum thickness .078", max warpage .011"
3). never wipe with rags or dip in solvent
4). always oil new plates before installation
B. 7 driven plates (steels)
1). -84A plates may not fit over -84 hub
2). service: minimum thickness .044", max warpage .011". install with rounded side out (all plates should slide freely over the hub)

14. Clutch shell
A. ring gear and sprocket are shrink fit (same slippage of ring gear noted on early productions)
B. do not pry on shell fingers = breakage

15. Clutch hub
A. pressed into hub bearing which is pressed into shell with clips for retention
B. installing and removing hub ruins bearing
C. hub nut must be torqued (over tightening cracks taper area), torque to 50-60 ft-lbs. use loctite 242
D. check key height, .119" max
E. clean taper with contact cleaner

F. updates:
    1). -84A hub, some problems noted in 91' and 92'
        a). runs eccentric to shaft
        b). not fully machined
        c). splines to large for -84A steel plates
    2). clutch problems
        a). misadjustment
        b). wrong lubricant
        c). low level lubricant
            d). customers driving habits

16. Transmission (transmission top is removable in frame, must move oil tank)
    A. 4 speed , constant mesh, sliding gear, direct drive, 1 to 1 ratio in 4th gear
    B. history:
        1). '36, 1st year of manufacture, '52-E79, drum type shifter (ratchet top), L'79-85, flat plate shifter
    C. lubricant: H-D Transmission Lube(not sport transmission lube), semi-synthetic gear lube
        1). good alternative: 84/140 hypoid gear oil
        2). quantity: 24 ounces,(3/4 quart)
        3). level indicator: motorcycle must be upright and level
            a). allen plug on cover
            b).bottom of filler plug threads
    D. venting: flat plate shifter, two holes in top cover
        1). oil leaks at clutch tower usually indicates overfill or vent plugged

17. Shifter mechanism
    A. shifter cam moves forks
    B. pawl arms move cam
    C. pawl carrier holds arms
    D. pawl carrier springs recenter carrier after shift
    E. shift shaft moves pawl carrier

18. Inspections
    A. shifter plate inspections:
        1). bent or worn more than .010", replace
        2). check for smooth fimger movement
        3). do not re-use snap ring
    B. pawl arm inspection:
        1). hook area wear
        2). pawl spring wear
    C. pawl carrier inspection
        1). broken or out of place(causes limp shifter)

D. cam follower inspection:
    1). bad spring; ID, cad plated(too stiff), coil binds
    2). good spring; ID, black, P/N 34068-52
E. shifter shaft inspection
    1). popping out of groove, use washers to shim

19. Sprockets
    A. left hand threads
        1). mainshaft- clutch hub nut and sprocket nut
    B. lock brake or lock in 2 gears to remove sprocket nut
    C. tab washer lock; ‘83 and earlier
        1). early style lock, bend tab only once
        2). torque nut to 80-90 ft-lbs., and use locktite 262
    D. allen lock; ‘83 and later
        1). torque nut to 80-90 ft-lbs,(120 max)
        2). allen screw location must prevent nut from loosening
        3). retro’s to all ‘80 models
    E. sprocket types: dished, ‘36-’79, installs with dish towards transmission, ‘80-’85, flat
    F. sizes: 22-24T, Ok for clearance to tranny: 25-26T, may require machining the case for clearance

20. Kicker cover
    A. spring and shaft, align tab at 5 o’clock position
    B. kicker gear dowel, align at 7 o’clock position
        1). when together in the case, the dowel and the tab are aligned

21. Starter clutch and outer gear has rectangular keyway
    A. starter clutch (gear), 2 ratios
        1). early, 14T: discontinued
        2). late, 16T: more leverage

22. Shifter forks
    A. shaft; e clip, always replace
    B. steel, all gears, -36 p/n, counter and main are different
    C. fork blocks
        1). ‘36-E’76, rounded, 1 notch
        2). L’76-E’79, square, 1 notch
        3). L’79-’85, square, 2 notches
    D. nuts face towards each other,torque to 12 ft-lbs.
    E. nut locks, bend only once

F. shims adjust forks,= gear spacing (shims go between fork and block only!)
G. shift finger rollers (top hats)
1).long- drum roller
2). short- plate shifter, and the XL
3). always replace

23. Countershaft (hand out page 3-14)
A. '36-'77,threaded, 1 grove. '77-'79, threaded, 2 grooves. '80-'83, notched
B. max bend, .003"(runout), max wear, .001"
C. 1st gera, free-wheeler, largest OD, half speed bushing, max clearance, .004" total.
1). thrust washer next on shaft
D. 1st and 2nd gear shifter clutch, "new", mounts in either direction, max backlash, .010"
E. 2nd gear, free-wheeler, second largest OD, half speed bushing, max clearance, .004" total
F. countershaft cluster, 3rd and 4th gear, most expensive, speedo drive in between 3rd and 4th gear
G. case race, heat case to press in
1). threaded, 1 groove shaft,shouldered race on kicker side, no shoulder on other race, use loose roller bearings
2). threaded, 2 groove shaft is .005" smaller in OD, need different bushings, used with caged bearings
3). notched shaft, same as 2 groove

24. Mainshaft
A. different lenght shafts, pushrods also
1). '36-'64, short, kickstart
2). '65-'69, long, electric start
3). '70-E'80, longer, AC generator
4). L'80-E'84, same length, different diameter
5). L'84-'85, longest, wet clutch
B. max bend, .003", max wear, ..001"
C. 1st and 2nd gear, fixed, pressed on (FL, early FX, and late FX)
D. 3rd gear, free-wheeler, bearing offset (causes a little whine), steel on steel, always replace clip
E. 3rd amd 4th gear clutch, marked "high" on one side for correct installation, dog ramps should angle to point towards rear. max backlash, .010"
F. 4th (main drive gear), free-wheeler, bushing clearance .004" (good .001"-.002")
1). installation of bushing requires a special tool and the direction is important. spiral or closed groove end installs toward the seal. leave enough room for the seal (1/4"-5/16"). hone or ream to size
2). endplay, L'77-'81, .0025"-.0135"; M'77 and earlier, and '82-'85, .010"-.025"

25. Drive gear area leaks
    A. to locate use solvent or kerosene in transmission
    B. areas:
        1). seal to case
        2). seal to spacer, polish spacer and check for grooving, install new seals, pre-lube lip
        3). spline leaks
    C. '82-'85, use p/n 11166 o-ring to seal splines, new spacer p/n (for use with o-ring), chain, 35079-84, belt, 35070-84
    D. '81 and earlier, clean all parts with contact cleaner before assembly

26. Bearing changes
    A. '36-E'77, 44 loose roller bearings around main drive gear
        1). available in STD. .0004" and .0008" over size
    B. M'77-'85, caged bearings
    C. to change early countershaft free bearings to caged, you need:
        1). late cluster gear
        2). late countershaft (threaded, 2 groove or notched)
        3). late case races
    D. throw out bearing
        1). '36-M'75, automobile style bearing (best style)
            2). M'75-'85, wafer style bearing, takes the same load as auto style bearing (won't live with a constant load)(clutch adjustment is critical). has a sheet metal oil slinger

Batteries

1. Penned in date on top (should not sit on shelf for over one year). see service bulletin M1020
    A. Number = year
    B. Letter = month
    C. Example: 8L = Dec. '88
2. Late model chart for battery coding (see hand out)
3. Putting battery into service
    A. Take off vent plug
    B. Remove cap farthest from vent, set on hole
    C. Install vent tube, blow in tube, it should move the cap
    D. Check strength of the electrolyte, it should be 1.265-1.270
    E. Fill each cell with electrolyte to lowest level. set aside for 30 minutes
    F. Rock battery to release trapped air and fill to upper level
    G. Charge battery at 1/10 amp hour rating until fully charged. full charge is 1.270-1.280 specific gravity
4. Battery type
    A. 19 amp. black with yellow caps

B. 22 amp. white with green caps
C. 32 amp. black with green caps

5. Battery data
   A. Conventional, charge a minimum of 6 hours, max temperature of 113 degrees F.
   B. Low maintenance, charge a minimum of 12 hours
   C. Check specific gravity of a battery after it has charged (let sit for a couple of hours before checking)
6. Battery charger type
   A. Taper rate charger, 2,4,6,8 ratings. use 2 amp charge, after first hour it should indicate 1-2 amp charge
   B. Christie fixed rate charger, good for bringing a dead battery back to life
7. Servicing a used battery
   A. Visual inspection- case and terminals
   B. Inspect battery carrier
   C. Check for sulphation and sediment flaking
   D. Connect battery, tight, clean connections, 2 finger method, use dialectric grease or petroleum jelly on terminals
      1). loose connections cause voltage spikes that damage electrical components
8. Battery testing
   A. Check specific gravity with a hygrometer, full charge is1.270-1.280 at 80 degrees
      1). for every 10 degrees hotter, add .004 points
      2). for every 10 degrees cooler, subtract .004 points
      3). max cell variance is .050 points
   B. Load testing (wear safety glasses)
      1). formula: 1/2 the cold cranking amps
      2). minimum voltage at end of testing is 9.6 volts
      3). don't test with a specific gravity of less than 1.240
      4). check for bleeding with a multimeter
         a). VDC scale
         b). negative lead to negative lead of battery
         c). positive lead to each battery cap, bad is more than 2.2 VDC
      5). voltage output (can be done with battery in bike)
         a). turn ignition, lights, and accesories on
         b). VDC scale, minimum of 11 volts at terminals

AIR FILTER SERVICING

1. Paper, tap lightly, blow it off with air (not more than 30 PSI)
   A. If filter is oily, it can be cleaned with soap and water
2. Foam, wash with a strong detergent than rinse. when dry, apply 1 tablespoon of oil to element , squeeze in and use paper towels to soak up excess
3. Gauze (K&N), wash in a strong detergent than rinse, shake off and air dry (not air pressure). spray with light coat of K&N oil on outside until gauze is pink
4. Ham can order of assembly

A. Manifold to head
B. Carburator to manifold
C. Air cleaner backing plate to carburator
D. Align and tighten support bracket “last” (prevents pulling manifold from heads which causes air leaks)

THROTTLE CABLE ADJUSTMENT

1. Lubricate cable with a light viscosity lubricant
2. Insure proper routing of cables (not pinched or crimped)
3. Pull open cable, with front end straight, open throttle wide open
   A. Adjust pull open cable until crank on carb. just touches carb. stop, snug locknut
4. Return cable, turn front end all the way to the right lock
   A. Adjust pull closed cable to eliminate freeplay between outer cable and cable spring
   B. Check throttle snap back in left, right and straight position (throttle must turn freely in any front end position)
   C. Carburator overflow hose must be routed away from exhaust
   D. Inspect fuel system for leaks or damage: hoses, fuel valve (lubricate)

VEHICLE INSPECTION

1. Around the vehicle inspection similar to PDI (Pre-Delivery Inspection). see inspection hand out
   A. Right rear
   B. Right side
   C. Right front
   D. Left front
   E. Left side
   F. Left rear

OIL CHANGE PROCEEDURE

1. School vehicles
   A. Drain oil into a clean pan and refill tank with original oil
   B. R&R oil filter, reuse old filter
      1). when tightening, turn oil filter1/3-1/2 turn after gasket contacts housing
   C. R&R tappet screens on big twins and clean (use modified snap-on drag link socket)
2. Real world
   A. Drain oil from tank

1). drain hoses where used as early as ‘83 on XL’s
2). all H_D’s have a drain plug or drain hose
3). fill to proper level with clean oil

B. Oil filter, always lubricate rubber gasket before installation
C. Do not install return side oil filter until system has been flushed
D. ‘84 and later Xl engine is on the fuel side, install before starting with filter 1/2 full of oil

3. Refilling system
   A. First, refill oil tank with recommended oil
   B. Start engine and run until clean oil exits oil filter housing (this flushes old oil out of the lines and crankcase)
   C. Always replace drain plug gasket

CARBURATION

1. It is illegal to altercarb (remove tamper plug)
   A. It is legal to:
      1). adjust slow idle RPM
      2). adjust fast idle RPM
      3). adjust float level
      4). adjust accelerator pump spring tension or pin setting
      5). adjust choke spring
      6). adjust idle mixture if screw is exposed
2. Idle mixture adjustment
   A. Should be performed after ignition timing is set, valve train adjustment, air filter service, and spark plug inspection
   B. Motorcycle must be at operating temperature
   C. Proceedure: check manual for initial settings:
      Bendix, ‘72-’73 XL and FL/FX 1 1/2 turns out
      Keihin, 2 turns out
      1). set idle speed to 900 to 1100 RPM (left side carb)
      2). slowly turn mixture screw clockwise to lean out
      3). when rear cylinder firing faulters, stop turning screw
      4). turn screw counter clockwise 1/8-1/4 turn until rear cylinder fires approxamately 75-90% of the time
      5). adjust idle speed as necessary

IDLE MIXTURE SCREW(stock set up)

2 turns	1 1/2 turns	1 turn
more than this	normal	less than this
jet is too small	initial setting	jet is too big

3.Fast idle, Keihin, (adjust only with engine cold)
   A. Adjust idle for 1500 RPM when choke is in #2 position (right side of carb)

   B. Misadjustment
      1). too little; no “fast” idle
      2). too much; overrides slow idle adjustment, engine “races”
4. Choke, cable adjustment provides full open/full closed settings
   A. Keihin carbs provide spring tension adjustment, if spring is weak, choke plate will open when cranking engine to start, will cause a lean mixture
5. Air leak problems
   A. Symptoms:
      1). erratic idle
      2). spit back through carb
      3). hesitation, surging
      4). poor performance,detonation
      5). slow return to idle
6. Air leak diagnosis
   A. Using contact cleaner, spary around manifold area, throttle shaft
   B. Air leaks produce a change in idle speed when contact cleaner is sucked in <u>DO NOT SMELL EXHAUST, IT WILL RESULT IN DEATH</u>
   C. Commercial tools for air leak detection are: snap-on propane leak detector, electronic air leak detector

PRIMARY DRIVE always have battery disconnected before opening primary drive

1. Inspection
   A. tight spots, check chain slack all the way around, more than 3/8” differance between tightest and loosest spot, replace chain
   B. corrosion, link damage, or heat damage, replace chain
   C. inspect adjusters for excessive wear, fastener tightness and bracket condition
   D. oil levels: XL(on sheet), FL ‘65-’84 1/2, none
2. adjustment
   A. XL, 3/8”-5/8” (chain link height)(use inspection cover)
   B. Big twin, 5/8”-7/8”

FINAL DRIVE

1. Inspection
   A. Replace any chain that shows:
      1). any rust between rollers and side plates
      2). has battery acid corrosion
      3). has more than 1/2” differance between tight and loose spots
      4). has roller or side plate damage

5). measures longer than 12 7/8” for 20 links
6). has kinks

B. Replace any sprocket that shows wear
1). teeth should almost have square teeth, no hooks or fins

2. Adjustment
A. Always adjust at the tightest spot
B. Measure chain alignment
C. With axle alignment tool, measure swing arm pivot to axle distance
D. With alignment tool attached to chain at rear sprocket, check alignment of chain to gauge
E. By sighting chain for alignment between sprockets, chain deflection is checked at bottom strand
F. Fasteners
1). torque axle nut and replace cotter pin
2). snug axle adjuster screw and locknut
3). readjust brake on mechanical brake models

3. Rear chain R&R
A. Loosen rear axle nut and chain adjuster
B. Bump wheel assembly towards the front
C. Remove the old master link
D. Attach the new chain with old master link
E. Pull old chain to feed new chain on to sprockets
F. Insure new chain is correct length
1). correct new length should put axle almost all the way forward
2). chain can be shortened 2 links at a time with a chain breaker
a). grind staked ends of pins off appropriate links with a grinder
b). use chain breaker to push pins out
G. Install new masterlink, squeeze side plates over pins, using vice grips and a small nut, install safety clip so closed end points toward direction of travel

BRAKE SYSTEM

1. Inspections
A. Master cylinder and linkage, damage or leakage, failure to return fully when released, or sponginess when applying pressure
B. Perform a stationary test: squeeze lever or depress pedal as hard as possible to make sure the system will not leak or fail. make sure system releases and wheel turns freely
C. Check fluid for contamination and level: any problem with master cylinder requires rebuilding or replacement. fluid change level should be 1/8” from top(with reservoir level)
D. Linkage inspection, damage, wear, non-stock parts
E. Adjustment inspection, freeplay must exist in most brake systems
1). ‘81 and earlier front master cylinders should have some freeplay. ‘82 and later do not

2). ‘85 and earlier rear brake systems must freeplay

F. Front master cylinder
1). ‘72-E’81, Lester, has built in freeplay
2). L’83 and up, Kelsey Hayes, has no freeplay, internals are held in place by a seal ring. 5 bore sizes
a). ‘82 only had 3/4” bore
b). ‘83-’95, had 5/8” bore on a single disc and 11/16” on a dual discs
c). ‘96 and up had 9/16” on singles and 13/16” on duals

G. Rear master cylinders
1). ‘58-E’79, Wagner Lockheed (cast iron)
a). ‘58-E’72, hydraulic drum
b). ‘72-’79, disc brakes
2). ‘79-E’87, Kelsey Hayes, (aluminum), requires a minimum of1/32” freeplay, do not over torque
3). ‘80 and up, FLT, FXR, FXST, used remote reservoir, freeplay 1/32”
4). cartridge type, very rarely have to rebuild
5). L’87 and up, built in freeplay, replaceable cartridge

H. Hoses and lines
1). damage, leaks and weather cracking
2). check for bulging or swelling when system is pressurized
3). replace any parts not in excellent condition

I. Calipers
1). damage, leaks, worn pivot points, non-stock parts
2). calipers must be free floating, fasteners tight
3). pad condition, correct parts, damage, wear, uneven or less than 1/16” thickness requires replacement
a). 1/2” pad thickness is better
4). half shim goes between piston and pad, rotor must turn into cut in pad. full shin goes between back side of caliper and pad
a). purpose of half shim is to clean rotor and pad

J. Discs
1). damage: max warp, .008”, max runout, .008”, (dial indicator mounted to front fork leg and spin disc), thickness: minimum thickness is stamped on the rotor (check in at least four places, with no more than .002” variance)
2). rotor is the only part with the part number stamped on it
hand-out pages 5-17 to 5-21, bulletins on brakes and pads

K. Disc and pad sets

DISC	PAD
-73, mild steel	organic
-78, hard stainless	semi iron, black (color)
-79, very hard stainless	semi iron , copper
-84, very hard stainless, 11/12” rotor,	semi iron, copper
-84A, 30 hole, anti symmetrical	semi iron, copper
-94, softer stainless	semi iron, gray

BRAKE FLUID

1. Description

   Dot 3, glycol based (clear), hygroscopic, eats paint and plastic, 5K miles, have no markings, has 3/4 mark

   Sep. '76, service internal components, cup inside master cylinder

   Dot 5, silicone based (purple), aerates, won't harm paint or plastic, 15K miles, 2 yellow and 1 white dots, has 750 mark

   note: when you have metal to rubber; use Dow Corning-44: for metal to metal, use anti-seize

BANANA BRAKE

1. '72-E'80, caliper body is the same for front and rear, differance is in the piston
2. 3 pistons = 3 retraction rates (color painted on pucks)
   A. Plain- front
   B. Red- front or rear
   C. Gold- rear (most retraction)
3. Changes
   A. '77-'80, wave washer was added to aid in retraction
   B. '73-E'81, boomerang bracket was used
   C. L'81-'84, "Y" bracket replaced boomerang
   D. L'80-'84, cut groove and put square ring in body (no longer in the piston, 1 retraction rate)
      1). undercut determines rate of retraction

COMPRESSION TESTING

1. Proceedure
   A. Remove spark plugs and join wires together with 1 plug to prevent arcing and possible fire
   B. Open throttle to wide open position
   C. Turn engine over until compression tester shows less than 5 psi increase per compression stroke
   D. Both cylinders should read within 10% of each other
   E. Most H-D engines will produce 100 psi or more
2. Differance of more than 10% between cylinders or compression below 100 psi, should be diagnosed
   A. Put 1 tablespoon of motor oil in cylinder and test again
      1). psi higher now?, rings are not sealing
      2). psi same ?, suspect valve or gasket sealing problem

PUSHROD AND TAPPET ADJUSTMENT

1. see tech 1 notes, check pushrod adjustment, than run engine and change oil

FRONT AND REAR SUSPENSION

1. Check for any loose fasteners, check for any damage
2. Check for any noticable dampening
3. Check for any fluid or air leaks

FORK STEM BEARING INSPECTION

1. Check for any looseness in bearings
2. Check that front end pivots smoothly
   A. cables should not be binding movement
3. Check adjustment
   A. FLT/FLHT, swing method
      1). disconnect clutch cable from handlebar
      2). support vehicle evenly off of the ground
      3). pull front end to left lock and let go, front end should swing past center twice and stop somewhere near center
   B. All other models (except springer), use 1”-2” fall away method
      1). disconnect clutch cable and any other restrictive cables
      2). support vehicle evenly off of the ground
      3). put front end in balanced position
      4). set pointer for reference and move front wheel to the left and than to the right
         a). note where the front end “falls away” in each direction
      5). left and right fall away marks should be 1”-2” apart

REAR SUSPENSION

1. There should be no noticeable side play in rear fork
2. There are several types of rear fork bearing designs:
   A. Tapered bearings require grease and adjustments
   B. Solid stainless plug and Teflon bushing requires no service
   C. Silicone rubber “clevblock” design requires no service
3. Always check torque specs’ on any fasteners
4. 4-speed swing arm bearing adjustment proceedure
   A. Remove everything from swing arm and let it hang free
   B. Connect fish scale to axle
   C. Lift swing arm with fish scale, check weight (12-15 lbs.)

D. Torque pivot bolt to increase weight by 2 pounds

AIR ASSISTED SUSPENSION

1. FLT,FLHT,FXRT moselshave front and rear sysstems
   A. Always check manual during service with no loss air gauge, see manual for specs'
   B. Check for leaks in 2 ways
      1). loss of pressure as read on gauge
      2). using soap and water
2. Anti-dive check
   A. Hold front brake, ignition off and bounce front end
   B. Hold front brake, ignition on, and bounce front end same amount. there should be noticeable increase in spring tension

WHEEL AND TIRE INSPECTION AND SERVICE

1. Tires: wear, replace tire if wear pattern is uneven, wear bars are exposed, or vehicle handles poorly
   A. Damage inspection, replace tire if sidewall shows damage such as cracks or puncture. replace tire if tread area puncture is sideways to carcas or puncture size is greater than1/4". also inspect for correct mounting, bead seated evenly and tire rotation
2. Service, tire pressure should be set to factory specs'and should not exceed maximum listed on side wall
3. Wheels, spin wheel to inspect for any damage or out of true
   A. Feel for bearing end play (.002"-.006")
   B. Cast wheels, if out of true or cracked,replace
      1). max runout radial = 1/32", lateral, 3/64"
   C. Spoke wheels, check spoke tightness, each spoke should emit a high pitched ring when tapped, all spokes should sound the same
      1). max runout radial and latera, 1/32"

MISC. LUBRICATION

1.Wheel bearing grease (can), p/n 99855-89, (cartridge), p/n 99856-92
   A. Except '80-'81 FLT
   B. Any taper bearing
   C. Any part with a grease fitting
2. H-D high temperature grease, p/n 99862-72
   A. Points cam
3. Anti seize, some brake caliper pins, axles, front brake lever pins, throttle sleaves
4. Triflo/Lubit 8/Tufoil, teflon lubricant, p/n 94968-85TB, cables, bracket and lever pivot points, shift linkage, clutch lever, locks and hinges and fuel valves

IGNITION SYSTEMS

1. Battery point ignition (BPI)
   A. Spark plug condition
      1). broken porcelain, detonation
      2). shiny black coating, oil burning
      3). dry black coating, rich condition
      4). yellow deposits, deposits burned to insulator
   B. Coil wires
      1). plug wire
         a). visual inspection of insulation for cracking
         b). terminal for looseness or corrosion
         c). trouble shoot for bad wire using water mist (wire will arc to ground)
      2). primary wire
         a). terminals loose at coil
         b). bad connection of wire to terminal
      3). Ignition coil
         a). inspect for cracks at mounting area
         b). plug wire terminals and primary wire posts
   C. Points/Condenser
      1). inspect contact points, replace if pitted across more than 1/3 of surface, replace if any damage is noted or if rubbing block is worn
      2). always replace condenser when replacing points
      3). advancer mechanism, typical high wear areas, springs, pins, shafts, and weights. typical damage area, small locating pin at cam pin
2. Maintenance
   A. Spark plug gaping
      1). bend side electrode to adjust
      2). do not use automotive style adjuster, use wire gauge
      3). adjust gap to, .028”-.032”
   B. Advancer lubricant
      1). light adequate lubrication of all moving parts with anti-seize
   C. Points cam lubrication
      1). light coating of H-D hi temp grease, p/n 99862-72
3.
   A. Rear cylinder fires first
   B. Point cam, wide lobe = rear cylinder, narrow lobe = front cylinder
4. Ignition timing
   A. Point gap, set gap on wide lobe, .018”, check gap on narrow lobe, should be .018”, $\pm$ .002”, if not, recheck advancer for wear or misalignment on cam
5. Static timing
   A. Set point gap on wide lobe, than check point gap on narrow lobe
   B. Time off of front cylinder advance, back engine 1/2” of piston travel to find front cylinder advance mark

C. Disconnect coil wire to points
D. Use diode check on meter, set advance plate where beeping from meter is intermittent (with points advanced!!!)

6. Check dynamic timing with a timing light
   A. 2000 RPM for BPI system
   B. Adjust plate, not points
7. Electronic ignition
   A. Inspection
      1). plugs, wires, coil (same as BPI)
      2). VOES, vacuum operated electrical switch
         a). vacuum switch
         b). requires a good ground
         c). check for damage
   B. Types
      1). 1st year, '78 1/2-'80, Prestolite, points cam, mechanical advance, adjust air gap, .004"-.006" with a brass feeler gauge (.060"-.065' XL's)
      2). '80-E'83 XL, '80-'84 big twin, Magnavox stage I, electronic ignition coil, electronic advance,6 wire system, 3 to sensor plate, 2 to coil, 1 to ground
      3). L'83 and up XL, '84 and up big twin, Magnavox stage II, VOES, 7 wire system, voilet wire to VOES
   C. V.O.E.S.
      1). grounded- advanced- high pressure
      2). ungrounded- retarded- low pressure

mode	throttle position	load	voes	violet wire
advance- economy	1/8-1/4	high	closed "on"	grounded
retard- power	1/2- wide open	low	open "off"	ungrounded

   D. Magnavox rotors, silver, '80-'83, stage I: gold '83 and up, stage II
   E. Rotor cup
      1). window closed,sensor ground, 0 VDC at green wire
      2). window open, sensor not grounded, power supplied to red wire up to 4.5-5.5 VDC('90 and up, 10VDC)
      3). rotor spins at half engine speed
   F. Ignition coils (collapsing field)
      1). '63-'79, points coil, low output 17 KV
      2). '80-'83, electronis coil, higher output 22 KV
      3). '84 and up, mailbox style 28 KV
      4). screamin' eagle 39 KV
      5).check for voltage at input and output of coil
         a). primary must be 9.6 vdc minimum
   G. Rev limiters
      1). Xl models 5400 RPM
      2). big twin 5200 RPM
      3). screamin' eagle 8000 RPM

CHARGING SYSTEM

1. Components
   A. Battery
   B. Stator
   C. Rotor
   D. Regulator
2. Quick test of charging system
   A. Use meter across batteryon bike not running (check VDC)
   B. Recheck with bike running, voltage should increase 13.5-15 vdc (this is not conclusive)
3. Stator (coil of wire)
   A. To check stator, disconnect regulator, set meter to ohms, and check lead to lead
   B. Should have resistance, check manual for specs'
   C. Check for grounds, lead on stator to ground, should read OL (check both leads)
   D. Ac voltage output checks (checks the rotor)
      1). set meter to vac, and place leads pin to pin
      2). run bike at idle and read meter
      3). run bike at 2000 RPM and read meter, reading should be double
      4). run bike at 3000 RPM and read meter, reading should be triple
      idle =20 vac, 2000 rpm = 40 vac, 3000 rpm = 60 vac
   E. Current draw
      1). set meter with red lead in 10 amp position
      2). turn on ignition, high beam, passing lamp, etc. (except brake light), read meter, if under 7 amps, turn on brake light
      3). check total loads against total amps in charging system
      4). must have a minimum of 305 amps returning after loads to maintain battery
   F. Regulator
      1). ground, from shiny edge of fin to to ground, should read OL
      2). system draw, "key off", 10A scale, should read zero
      3). disconnect regulator lead at circuit breaker, so system drain test again (minimal amount of drain ok)
      4). regulator bleed, check each pin, should be zero

WHEEL R&R

1. Key points
   A. Do not disconnect chain
   B. Remove chain or belt guard
   C. Don't remove caliper assembly, compress piston by hand and tie up out of the way
   D. Don't loosen chain or belt adjusters
   E. Remove axle, slide wheel forward,and remove air from tire
   F. Remove chain or belt from rear sprocket and remove rear wheel

G. On reinstallation, be sure brake pads are aligned properly before inserting brake disc
H. Recheck adjusters and adjust if necesary, chain or belt, alignment or tension
I. Pump brakes until firm, check for smooth release

2. '80-'84 FLT/FXRT (rear wheel removal)
   A. Raise rear wheel
   B. Remove both saddle bags and mulfflers
   C. Remove plug in tower chain housing, use long sheilded 3/8" allen socket, remove all 5 sprocket bolts
   D. Connect a ratchet strap to upper shock mount and swing arm, remove lower shock bolts, lower swing arm enough to remove brake caliper anchor bolts
   E. Pull axle 3/4 of the way out
   F. Lift out caliper and hanger and secure out of the way
   G. Deflate tire, seperate wheel from sprocket, tilt wheel, carefully remove
   caution- be careful of inner spacer falling out of wheel
3. Installation
   A. Reverse order of removal
   B. Don't forget the inner spacer
   C. Clean and lubricate bolts
   D. Torque sprocket bolts to 65-75 ft-lbs. cross pattern
   E. Torque axle to 60 ft-lbs.
   F. Readjust caliper anchor bolts
   G. Mount mufflers forward on bracket
   H. Inflate tire
   I. Pump brakes